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TV Games *In Colour*

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Part 1

THIS seems to be the year of the TV game. Take a look in the radio and television department of any large store and you are likely to find various television games units on sale. Most readers, being electronically inclined, would probably prefer to be able to build their own TV games unit however. *Television* has therefore developed a constructional project which provides a TV games centre having a number of advanced features which are not available on most other TV games units.

TV games are not new of course, but until this year the construction of a suitable unit would have involved the use of a large amount of complex logic and even then would provide only a simple game such as television tennis. Most TV games were to be found in amusement arcades. Realising that there was a potential market in TV games, some of the big semiconductor manufacturers developed special integrated circuits which could provide the complex logic required on a single chip. At first these were aimed at the amusement arcade and commercial games market but the devices are now at last becoming available to the home constructor so that the TV game becomes a reasonable proposition for a home construction project.

Most of the TV games units on sale in stores, and the few construction kits that have appeared recently, make use of the General Instrument type AY-3-8500 device. This will produce a selection of up to six different games, although most games units provide only four of these since the two rifle shooting games require extra equipment. The display on the screen is in black and white and includes an automatic display of the score each time a point is scored. The sound effects are usually reproduced on a speaker mounted in the TV game control unit rather than coming from the TV set.

For the *Television* games centre a newer and rather more sophisticated integrated circuit, from National Semiconductor, has been used. This is the MM57105 which, when used with the LM1889 video modulator chip, provides a full colour display on the screen, assuming of course that you have a colour receiver. Sound effects when the ball hits the bat or the boundary fence are reproduced on the sound channel of the television receiver, giving a more realistic result. Three basic games are provided, with practice versions of each. There are thus six games options to choose from. Other features, such as automatic on-screen scoring, ball control and automatic service, are included.

Before going on to deal with construction let us take a closer look at the games and features offered in this TV games unit.

Ice Hockey

Because the National Semiconductor games chip was originally developed for the North American market it is

not surprising that the first game provided is ice hockey. This is played on a blue field, representing the ice, and the wall around the playing area is marked out by a yellow line on the screen. At each end of the field the gap in the wall forms the goal. Each team consists of a goalie and three forwards which are displayed as yellow rectangles and squares respectively. Each player can move his goalie up and down the screen in front of his goal line by operating the player control. The forwards in each team are controlled by the internal logic of the game however and move up and down in a more or less random fashion.

The hockey puck appears on the screen as a small blue square and moves around inside the playing area, bouncing off the walls or players whenever it hits them. In fact the players will deflect the puck only when it's travelling in the direction of their goal line – otherwise the puck passes right through the player as if he was not there. The object of the game is to get the puck through your opponent's goal, thus scoring a point. Whenever the puck passes through either goal the current score is displayed for about a second before play automatically resumes. When one team has scored 15 points the game is won and play stops until a new game is initiated.

Tennis

The second of the games is tennis which, as one might expect, is played on a green court with blue borders at the top and bottom of the screen. In this game the rackets for the two players are shown as vertical orange lines whilst the net and scores are yellow.

The ball, which is pale green, bounces off the upper and lower borders of the court in much the same way as the puck does in the ice hockey game. In tennis the object of the game is to try to make your opponent miss the ball so that you score a point. The game is won when either of the players reaches a score of 15, and the score is displayed automatically each time one of the players fails to hit the ball with his bat.

Squash

The third basic game is squash which is played on a three sided magenta coloured court with both players at the same end. Only one of the bats is displayed at a time and will be that for the player whose turn it is to hit the ball. The two bats are displayed in different colours, one blue and the other orange. The scores are displayed in the same two colours. The pink ball can bounce off all three walls of the court, and points are scored whenever a player fails to intercept the ball on his turn. As in the other games the first player to get 15 points is the winner and play ceases at that point.

Practice

Each of the three basic games can be set up for single player practice operation. One of the player controllers then moves both bats or goalies together. This is a useful feature which allows beginners to get the feel of each game before playing in earnest.

Handicapping

One player will often be a lot more experienced than the other. To deal with this a system of handicapping can be used. There are three sizes of bat which can be selected for each player. The normal bat size is a line about $1\frac{1}{2}$ inches high on a 22 inch TV screen. An intermediate $\frac{3}{4}$ inch high bat or a small $\frac{1}{8}$ inch bat can also be selected for either player so that if the better player is given a smaller bat he will compete on more even terms with his less experienced opponent. Bat size is selected by moving the bat to be changed to the top of the court and pressing the player's reset button either once or twice until the desired bat size is produced.

Using this facility it is possible to play against the machine in the ice hockey game. One goalie is set to full size and positioned in front of the goal. The player's goalie is set to the medium size to give the machine a fair chance and the game is played by one player using the small goalie.

Ball Control

When the ball or puck hits one of the side walls it will rebound at an angle which depends upon the angle at which it actually hit the wall. This follows the same rules that apply when a ball hits a wall in real life. When the ball hits a bat however it has been arranged that the new direction of travel depends upon the positioning of the bat relative to the ball. This allows the player to direct the ball to the part of the court that he wants to send it to.

To achieve ball control the bat consists of eight segments, though it does not appear like this on the screen. If the ball hits one of the two central parts of the bat it will travel horizontally across the screen. When the ball hits one of the upper three segments it will travel at an angle towards the top of the screen. Each of the three segments produces a different angle, with the top segment giving the steepest angle and the one near the middle the shallowest angle. A similar action occurs for the lower three segments, except that the ball travels at an angle towards the bottom of the screen. Thus by placing the bat so that the ball hits it at the proper point the ball can be sent off at any one of seven different angles. The segments still operate on the smaller bat sizes but directing the ball becomes rather more difficult.

To simulate the conditions of a real match the ball is arranged so that it travels relatively slowly when play is resumed after a point has been scored. This simulates a service stroke in tennis. After the ball has been hit four times the ball speed automatically increases to make play rather more exciting.

The Circuit

Now let's us get down to the hardware side of the games unit. Fig. 1 shows the complete circuit diagram of the *Television games centre*.

Since the complex logic of the system is contained in three integrated circuits there is not a lot of other circuitry to be added, apart from a power supply and the u.h.f. modulator.

The game itself and the generation of the TV display are controlled by the MM57105 (IC1) which produces at its outputs the composite video/sync signal, with sound and chroma control signals, needed to generate the TV display. Inputs from the two player control units are used to determine the positions of the two bats and control the reset action. The actual game displayed is selected by switch S4 on the front panel of the games control unit.

Bat position is determined by the time-constant of the player control resistor (RV1 or RV2) and the timing capacitor (C1 or C2).

Network R3, C3 operates a power on reset circuit in the MM57105 so that when power is first applied all the internal logic is correctly reset and the ice hockey game is set up ready to start play.

The games circuit requires two non-overlapping clock inputs for proper operation. These are generated by the MM53114 clock generator (IC3). The input to this device is a 4.43MHz colour reference frequency, and from this all the timing and video output generation is derived.

The third special integrated circuit is the LM1889 (IC4). This is a special video modulator circuit designed to operate with video games. It produces full colour PAL signals modulated on to one of the two v.h.f. signal channels or can be used to produce just the required modulation signal.

One part of the LM1889 consists of a 4.43MHz colour reference oscillator controlled by the external crystal X1. Lead and lag networks producing 45° phase shifts are used to drive a chrominance modulator in the LM1889 which when fed with chroma control signals from the games chip will produce the required PAL chrominance subcarrier at its output.

Because we need a u.h.f. signal for use with a British television receiver the v.h.f. modulators in the LM1889 are not used.

A sound oscillator within the LM1889 uses the tank circuit L1, C12 to produce a 6MHz sound subcarrier which is frequency modulated by a control signal from the games chip to give the desired sound effects.

Video, sound and chrominance signals are all mixed together at pins 12 and 13 of the LM1889 and passed on to the u.h.f. modulator section.

The Modulator

A simple transistor oscillator using a BFY90 produces the u.h.f. carrier signal which, with the layout used, will give a signal at around channel 40. Increasing the value of C19 will enable the circuit to be tuned to a lower u.h.f. channel if desired.

Composite video is applied to the base of Tr1, which acts as an inverting, unity-gain amplifier. The signal is then tapped from the 1kΩ preset RV3 and injected at the emitter of the u.h.f. oscillator transistor. In this way the carrier is modulated by the video signal, the depth of modulation being varied by RV3 – adjust for optimum results. Because it is difficult to get full modulation, it may help to advance the setting of the receiver's contrast control.

Power Supply

Two power supply lines, at -9V and -15V, are needed for the MM57105 games chip. A simple full-wave rectifier gives the -15V supply which is stabilised by the 7815 fixed voltage regulator (IC2). For the -9V supply a 5.6 volt zener is used in series with the -15V rail to provide the necessary voltage drop.

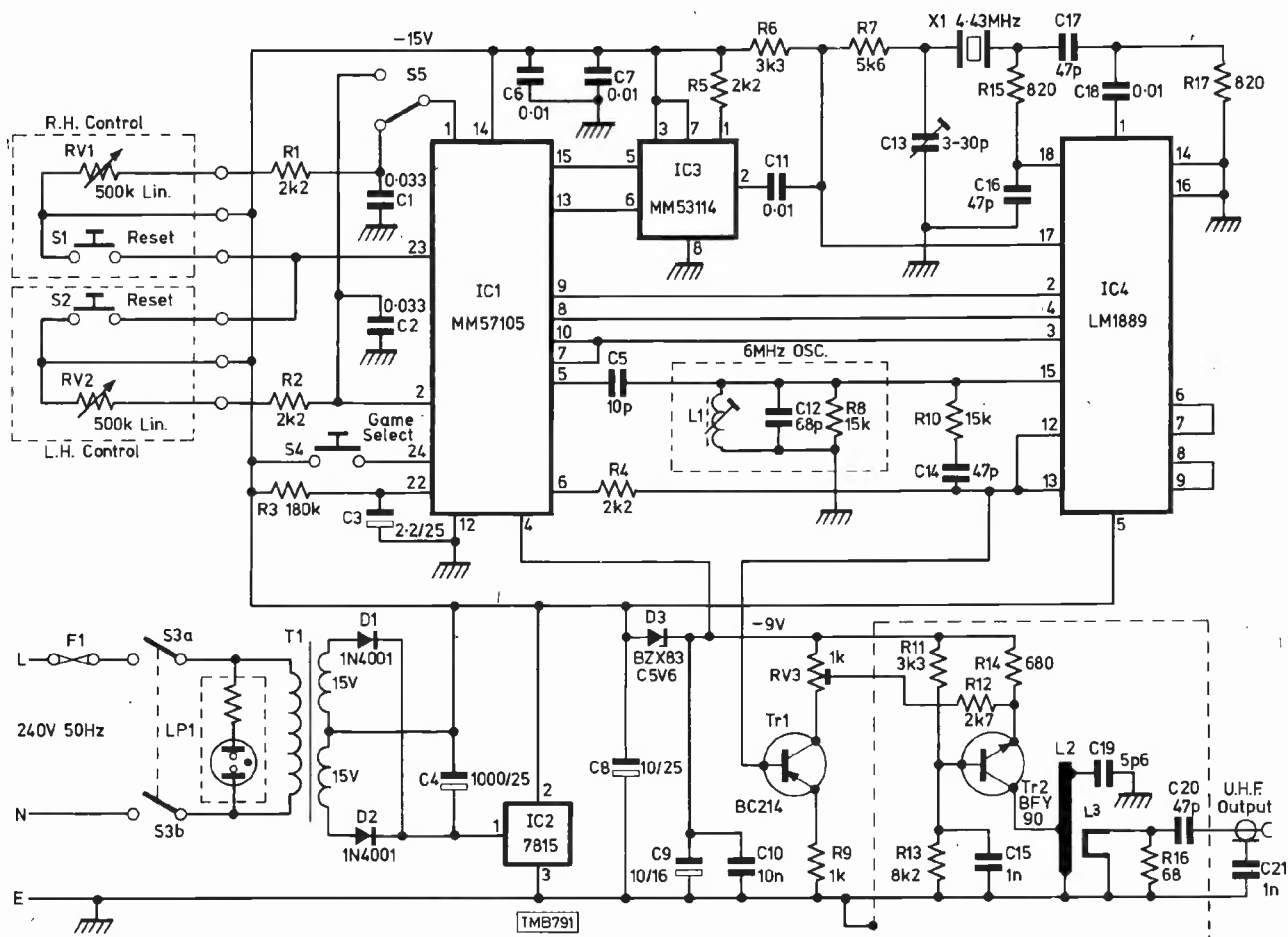


Fig. 1: Complete circuit diagram of the games unit.

★ Components list

Resistors: (all $\frac{1}{4}$ W, 5%)

R1 2.2k Ω	R7 5.6k Ω	R13 8.2k Ω
R2 2.2k Ω	R8 15k Ω	R14 680 Ω
R3 180k Ω	R9 1k Ω	R15 820 Ω
R4 2.2k Ω	R10 15k Ω	R16 68 Ω
R5 2.2k Ω	R11 3.3k Ω	R17 820 Ω
R6 3.3k Ω	R12 2.7k Ω	

RV1 500k Ω linear
 RV2 500k Ω linear
 RV3 1k Ω subminiature horizontal preset

Capacitors:

C1, 2	0.033 μ F polyester
C3	2.2 μ F tantalum bead
C4	1000 μ F 25V electrolytic
C5	10pF ceramic plate
C6, 7, 10, 11, 18	0.01 μ F ceramic disc
C8	10 μ F 25V tantalum bead
C9	10 μ F 16V tantalum bead
C12	68pF ceramic plate
C13	3-30pF ceramic trimmer
C14, 16, 17, 20	47pF ceramic plate
C15	1000pF ceramic plate
C19	5.6pF ceramic plate
C21	1000pF 1000V ceramic

Transistors and diodes:

TR1	BC214	D2	1N4001
TR2	BFY90	D3	BZX83 C5V6
D1	1N4001		

Integrated circuits:

IC1	MM57105
IC2	7815 15V regulator
IC3	MM53114
IC4	LM1889

IC1, IC3 and IC4 available as a set from A. Marshall (London) Ltd., 42 Cricklewood Broadway, London, NW2 3ET, price £17.00 including postage, packing and VAT.

Miscellaneous:

L1	50 turns 38s.w.g. enamelled close wound on standard 4mm TV coil former with can and tuning slug
L2, L3	Part of PCB
T1	Primary 240V Secondary 15V-0-15V 200mA
X1	Standard 4.43MHz PAL colour reference crystal
Case	Vero case type 1411
Hand controller boxes (Vero)	
Knobs for hand controllers	
S1	Min. Push button push to make
S2	Min. Push button push to make
S3	2 pole PC mount Push switch
S4	2 pole PC mount Push switch (Action link removed)
S5	2 pole PC mount Push switch
IC sockets	24 pin DIL, 18 pin DIL and 8 pin DIL (or Soldercon sockets)
PCB	Reference no. DO34

TV Games

In Colour (Part 2)

Steve A. Money, T.Eng.(C.E.I.)

Construction

It has been arranged so that all the components for the main control unit are assembled on a single printed circuit board which fits into a Vero case type 1411. Fig. 2 shows the track layout for the PCB whilst Fig. 3 shows the layout of the components on the board.

The three main integrated circuits fit into sockets which may be either low profile DIL sockets or made up from Soldercon socket pins.

In the u.h.f. modulator section it is important to wire the components in the positions shown, otherwise the output frequency or oscillator operation may be affected. When soldering the BFY90 transistor, it is advisable to use a small pair of pliers on the transistor lead to act as a heat shunt – these transistors are easily damaged by applying excessive heat to the leads. Using a heat shunt will allow a good joint to be made on the PCB whilst keeping the heat away from the transistor itself.

The leads for the player controls are most conveniently made from miniature three core mains cable – this is robust and neater than a twisted cable. The connections for the player controls are soldered directly to the main PCB. The

lead should be anchored to the case before being brought out, so that an accidental tug on the cable will not pull the connections off the printed circuit board. A similar anchoring of the cable in the player control unit is desirable.

Each player control uses a 500k Ω potentiometer for bat position and a push-button reset switch for bat size selection and to start a new game. With the 500k Ω control potentiometer, a rotation of just under 180° moves the bat from the top to the bottom of the screen. This has been found to give quite reasonable play control. If a more sensitive control is desired, the potentiometer can be increased to 1M Ω in which case a movement of about 90° moves the bat from top to bottom.

Setting up and Testing

Having thoroughly checked the wiring of the PCB for missed joints or illegal solder bridges, test the circuit with the three main integrated circuits removed from their sockets. Apply power and check that the –15V and –9V supplies are set at the correct levels. Couple the u.h.f. output to a television receiver and tune the receiver until the

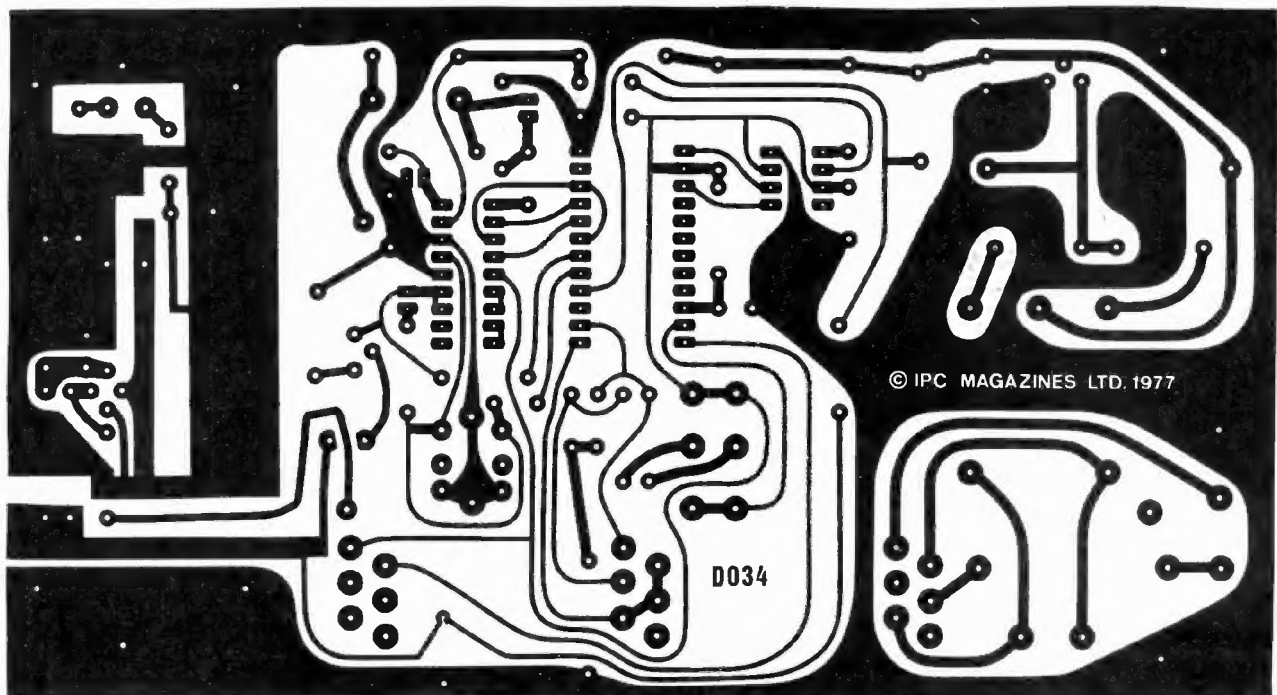


Fig. 1: Track detail of p.c.b. The board is available from Readers' PCB Services Ltd.

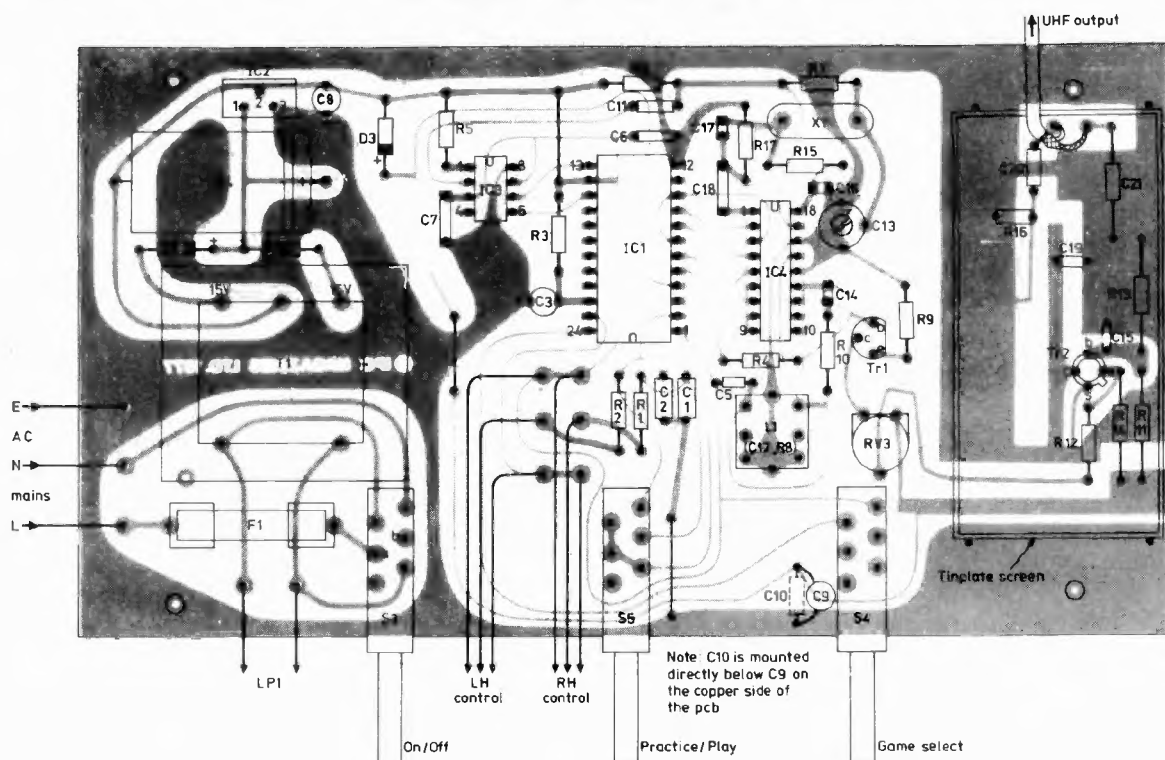


Fig. 2: Component location diagram. The metal screen enclosing the modulator is made up of strips of tin plate, about 25mm high and secured by soldering to the four pins inserted at the corners of the modulator section.

games unit's u.h.f. carrier signal is detected. This will be indicated by a reduction in the normal off channel noise to give a blank screen.

Switch off the power and insert the three integrated circuits, taking care to ensure that they are correctly orientated. When the power is turned on again it is likely that there will be some video modulation on the screen. If not, the colour reference oscillator is probably not set up correctly: adjust the value of C13 and try again. It may be necessary to switch the power off and on to ensure that the games chip resets correctly. Once video signals appear on the screen, retune the receiver for a locked display. If the display will not lock correctly it's likely that the sync pulses are being clipped. Adjustment of RV3 should clear this fault.

When the picture is locked in it should show the field for the hockey game since this is always selected at switch on. Press the game select button and check that the display changes to tennis. Pressing the game select button again should give the squash display. A further press of the game select button should bring back the hockey game.

With hockey selected, press one of the player reset buttons. After about two seconds the ball should appear and will travel around the screen. At this point there may be video buzz on the sound channel. Tune the sound sub-carrier coil L1 until the buzz fades out and the sound effects ping is heard each time the ball bounces off a wall or player.

On some receivers where the a.f.c. is permanently active it may be found that at switch on the receiver will lock to the sound or chrominance subcarrier and it will be necessary to retune the receiver for optimum picture display.

Check that the player controls move the bats up and down the screen. Bat size control can be checked by moving the bats to the top of the field and pressing the player reset button: the bats should change size each time the button is pressed.

There is also a time out facility after each point has been scored. If one player moves his bat off screen at this time

play will be stopped until he moves his bat back into the playing field: service will then commence and the game resume.

Having checked all the functions you are all set to start your first television games tournament. . . .

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